STRATUS
ENVIRONMENTAL, INC.

3330 Cameron Park Drive, Ste 550
Cameron Park, California 95682
(530) 676-6004 ~ Fax: (530) 676-6005

May 3, 2005
Project No. 2029-2400-01

Mr. Barry Marcus
Sacramento County Environmental Management Department
8475 Jackson Road, Suite 230
Sacramento, CA 95826-3904

Subject: Well Installation and Soil Vapor Extraction Test Work Plan
Kwik Serv Fueling Station
2400 Fruitridge Road
Sacramento, California
LOP #G028

Dear Mr. Marcus:

On behalf of Mr. Bal Soin, Stratus Environmental, Inc. (Stratus) has prepared this *Well Installation and Soil Vapor Extraction Test Work Plan* (*Work Plan*) for the Kwik Serv facility (the site), located at 2400 Fruitridge Road, Sacramento, California (Figure 1). In a letter dated February 16, 2005, Sacramento County Environmental Management Department (SCEMD) requested the installation of a vapor extraction well and a groundwater monitoring well in areas of the site where the highest concentrations of petroleum hydrocarbons in soil and groundwater have previously been detected. The February 16, 2005 letter indicated that following completion of the requested well installations, and completion of a soil vapor extraction test, SCEMD would evaluate closure of the environmental case for the site. This *Work Plan* presents details associated with completing the work activities requested by SCEMD.

SITE DESCRIPTION

The subject site is an operating service station situated on the southeastern corner of the intersection of Fruitridge Road and 24th Street, in Sacramento, California (Figure 1). The existing fuel storage system consists of one 12,000-gallon gasoline and two 10,000-gallon gasoline underground storage tanks (USTs) located in the northwestern corner of the property. There are five dispenser islands with associated product lines, four in the north central region and one in the west central region of the site. Figure 2 depicts the locations of the USTs, dispensers, and associated product lines.

BACKGROUND

The following was summarized from information obtained from SCEMD records, reports prepared by consultants representing previous service station operators, and work completed by Stratus. Former UST, soil boring, and monitoring well locations discussed in this section are illustrated on Figure 2.

Three USTs (10,000-gallon and 8,000-gallon tanks used to store regular unleaded gasoline, and one 6,000-gallon tank used to store premium unleaded gasoline) were removed from the site on June 29, 1987. These USTs were reportedly situated in the southwestern corner of the subject property. Total petroleum hydrocarbons as gasoline (TPHG) were apparently reported at concentrations up to 77 milligrams per kilogram (mg/Kg); sampling locations, analytical data tables, or certified analytical results were not located in the SCEMD records. An overexcavation was reportedly completed to remove hydrocarbon impacted soil in this area. Additional soil sampling apparently confirmed that the hydrocarbon impacted soil was removed from this area.

A 250-gallon waste oil UST was removed from the site in July 1987. The waste oil UST was situated on the south side of the station building, and a 990-gallon waste oil UST was installed in the same general area at this time. Gravimetric waste oil as petroleum oil (200 mg/Kg) was detected in a soil sample collected within the former UST cavity area.

A groundwater monitoring well (MW-1) was installed immediately west of the former waste oil UST in October 1987. This well was later re-named EW-1 in 1992. Well MW-1/EW-1 was sampled 16 times between October 1987 and August 1995. TPHG and benzene, toluene, ethylbenzene, and xylene (BTEX) concentrations were predominately reported below laboratory detection limits. TPHG and benzene were detected at maximum concentrations of 52 micrograms per liter (μg/L) and 0.98 μg/L, respectively, for samples collected during this 8-year period. Total oil and grease (O&G) was reported in two samples collected from the well, at concentrations of 70 μg/L and 500 μg/L.

Three soil borings (B-1 through B-3) were advanced to approximately 21.5 feet below ground surface (bgs) on October 19, 1990. Each boring was advanced within approximately 10 feet of the 990-gallon waste oil UST. O&G was apparently reported in samples collected from 6 feet bgs, at concentrations up to 530 mg/Kg. Soil samples collected from 11, 16, and 21 feet bgs were reportedly not impacted with O&G.

On December 18, 1991, the 990-gallon waste oil UST was removed from the site. An overexcavation was subsequently completed to remove hydrocarbon impacted soil in this area. The dimensions of the excavation were approximately 23 feet in the east-west direction and 20 feet in the north-south direction. Soil immediately beneath the former waste oil UST was removed to approximately 15 feet bgs; soil around the perimeter of the former waste oil UST cavity was removed to approximately 7 feet bgs. The excavation was backfilled with pea gravel. The quantity of soil removed from the subsurface, and soil disposal information, is currently unknown.

Three additional groundwater monitoring wells (MW-1 through MW-3) were installed on October 19, 1992. Groundwater was encountered at approximately 41 feet bgs at this time. TPHG and benzene were not detected in groundwater samples collected from these wells between November 1992 and August 1995. Petroleum hydrocarbons were not detected in any of the samples collected from well borings MW-1 through MW-3. Radial groundwater flow, to the north, northeast, east, and southeast away from well MW-2, was consistently reported for monitoring events completed in 1994 and 1995.

MVP Petroleum Engineers, Inc. (MVP) removed one 550-gallon fiberglass waste oil UST and replaced five fuel dispensers with associated product piping, on behalf of Kwik Serv, in December 2002, and January 2003. The former waste oil UST was situated in the same general area as the previous waste oil USTs. This fiberglass waste oil UST appeared to be in good condition. Compliance samples were not collected beneath the former waste oil UST due to extensive pea gravel in the excavation.

Analytical results from soil samples collected beneath the dispenser islands and along the product lines in December 2002, indicated petroleum hydrocarbons were present beneath the western dispenser island at depths of 3 to 4.5 feet bgs, and in the piping trench leading to the western dispenser island at a depth of 3 feet bgs. Low concentrations of petroleum hydrocarbons were also detected along the other product lines that supply the north central fuel dispensers at a depth of 3 feet bgs. TPHG was reported at a maximum concentration of 2,400 mg/Kg at 4.5 feet bgs beneath the western dispenser island. The fuel additive methyl tertiary butyl ether (MTBE) was reported beneath the western dispenser and along the associated product lines at a maximum concentration of 20 mg/Kg.

Stratus oversaw the advancement of six exploratory soil borings (B-1 through B-6) on-site between August 16 and 18, 2004, to further characterize subsurface petroleum hydrocarbon impact beneath the site. Groundwater was encountered at approximately 29 feet bgs at the time of this investigation. Fuel-based petroleum hydrocarbon concentrations were reported below laboratory detection limits for all soil samples collected from the borings. MTBE was detected in groundwater samples collected from three of the soil borings, at concentrations ranging from 0.98 μg/L to 12 μg/L.

Stratus submitted a *Water Supply Well Survey Report* on February 7, 2005, following an evaluation of water supply well usage in the site vicinity. The only water supply well identified during a California Department of Water Resources (DWR) records review and field reconnaissance, known to be currently in use, is situated approximately 2,100 feet south of the site and screened below 282 feet bgs. Based on the findings of the water supply well survey, Stratus concluded that potential risk to water supply wells resulting from dissolved petroleum hydrocarbon impact beneath the site was very low.

SCOPE OF WORK

The objective of the proposed work is to further characterize the extent of petroleum hydrocarbon impact to soil and groundwater. To accomplish this objective, Stratus is proposing the following activities:

- Advance one (1) soil boring to approximately 40 feet bgs using 8-inch diameter hollow stem augers. This boring will be converted to a 2-inch diameter groundwater monitoring well (MW-4).
- Advance two (2) soil borings to approximately 18 feet bgs using 8-inch diameter hollow stem augers. These borings will be converted to 2-inch diameter vapor extraction wells VW-1 and VW-2, screened between 3 and 18 feet bgs.
- Collect soil samples in 5-foot intervals during the advancement of the well borings.
- Develop and sample the newly installed groundwater monitoring well.
- Complete a soil vapor extraction (SVE) test, using wells VW-1, VW-2, and MW-4 for extraction.

The proposed scope of work has been subdivided into tasks 1 through 5. Details are provided for the activities associated with each task. All work will be conducted under the direct supervision of a State of California Registered Geologist or Engineer, and will be conducted in accordance with standards established by the *Tri-Regional Board Guidelines for Hydrocarbon Site Assessment and Remediation* (RWQCB 2004), and SCEMD guidelines. A California-licensed C-57 drilling contractor will perform all drilling and well construction activities. Stratus' Field Practices and Procedures, and a Quality Assurance Plan for all fieldwork, are included in Appendix A.

Task 1: Pre-field Activities

Following approval of this *Work Plan*, the following activities will be completed:

- Obtain well installation permits from SCEMD,
- Retain and schedule a licensed C-57 drilling contactor,
- Update the health and safety plan for the site,

- Mark boring locations and contact Underground Service Alert to locate underground utilities in the vicinity of the work site.

TASK 2: FIELD ACTIVITIES

Task 2A: Soil Borings

A licensed well driller will advance the soil borings using a limited access drill rig equipped with 8-inch diameter hollow stem augers. Boring MW-4 will be advanced to 40 feet bgs and borings VW-1 and VW-2 will be advanced to 18 feet bgs. Each boring will be completed as a groundwater monitoring or vapor extraction well, as described below. Proposed well locations are shown on Figure 2. The initial 5 feet of each boring will be advanced with a hand auger and/or posthole digger to reduce the possibility of damaging underground utilities. Soil samples will be collected at 5-foot intervals using a California-type, split-spoon sampler equipped with three pre-cleaned brass tubes. The ends of the bottom-most, intact tube from each sample interval will be lined with Teflon™ sheets, capped, and sealed. Each sample will then be labeled, placed in a resealable plastic bag, and stored in an ice-chilled cooler. Strict chain-of-custody procedures will be followed from the time the samples are collected until the time the samples are relinquished to the laboratory. Soil contained in the remaining brass tubes will be screened for volatile organic compounds using a photoionization detector (PID). Stratus will record PID readings, soil types, and other pertinent geologic data on a borehole log. A minimum of two soil samples from each boring will be submitted for chemical analysis. Additional samples may be selected for chemical analysis based on soil type and field observations. Details regarding exploratory boring procedures are included in Appendix A.

Task 2B: Monitoring Well Installation

Groundwater monitoring well MW-4 will be installed to a depth of approximately 11 feet below anticipated first encountered groundwater. Well MW-4 will be constructed using 2-inch diameter PVC casing and 20 feet of 0.02-inch diameter machine slotted casing, situated from approximately 20 to 40 feet bgs. A filter pack of #3 Lonestar™ sand will be placed in the annular space around the well casing from the bottom of the well screen to approximately two feet above the top of the well screen. Approximately three feet of bentonite will be placed on top of the filter pack and hydrated with clean water to provide a transition seal for the well. Neat cement will be used to backfill the remaining annular space around the well casing. A watertight locking cap will be placed over the top of the well casing, and a traffic rated vault box will be installed around the top of the well. The actual well construction may be modified in the field based on conditions encountered at the time of the investigation.

Task 2C: Vapor Extraction Well Installation

Wells VW-1 and VW-2 will be constructed using 2-inch diameter PVC well casing and 15 feet of 0.03-inch diameter well screen, situated from approximately 3 to 18 feet bgs. A filter pack of Lonestar™ medium aquarium sand will be placed in the annular space around the well casing from the bottom of the well to approximately 0.5 feet above the top of the well screen. Approximately one foot of bentonite will be placed on top of the filter pack and hydrated with clean water to provide a transition seal for the well. Neat cement will be used to backfill the remaining annular space around the well casing. A watertight locking cap will be placed over the top of the well casing, and a traffic rated vault box will be installed around the top of the well. The actual well construction may be modified in the field based on conditions encountered at the time of the investigation.

Task 2D: Waste Management

Drill cuttings and wastewater will be contained in U.S. Department of Transportation-approved 55-gallon steel drums. The drums will be appropriately labeled and stored at the site pending proper disposal. A licensed contractor will transport the soil and wastewater to an appropriate facility for disposal.

Task 2E: Monitoring Well Development and Sampling

The newly installed monitoring well will be allowed to stand a minimum of 72 hours before being developed. Monitoring well development will consist of surging with a bailer followed by groundwater pumping. Development will continue, to the extent practical, until the discharged water runs clean and pH and conductivity measurements stabilize. Water levels, water-quality parameters (pH, temperature, conductivity), and discharged quantities will be recorded for each well.

A minimum of 24 hours after well MW-4 is developed, the monitoring well will be purged and a groundwater sample will be collected. The sample will be collected using a disposable bailer, transferred to laboratory-supplied glass vials, and placed in an ice-chilled cooler. The groundwater samples will be transported, under strict chain-of-custody protocol, to a California-certified analytical laboratory for analysis. In the event that environmental case closure is not granted following the initial sampling event, a quarterly monitoring program will be initiated.

Task 3: SVE TESTING

Stratus will conduct three 3-hour single well SVE tests, using wells VW-1, VW-2, and MW-4 for extraction. If petroleum hydrocarbons are detected in any well, the test on that well will be extended to 8 hours. The SVE testing will be conducted using a trailer mounted 100 cfm electric catalytic oxidizer. The extracted soil vapors will be abated, using the catalytic oxidizer, before discharging to the atmosphere. Prior to beginning the tests, Stratus will notify Sacramento Metropolitan Air Quality Management District (SMAQMD) regarding the test schedule and duration.

The following parameters will be monitored and recorded on field data sheets during the system start-up:

- Vapor extraction rate,
- Applied vacuum,
- Well head vacuum,
- Influent flow into the system,
- PID measurements for organic vapors from the extraction well, and
- Induced vacuum at the non-extraction wells during each test.

A minimum of two influent air samples will be collected during each SVE test. The first sample will be collected within 0.5 hours of start-up, and the second sample will be collected immediately before system shut down. In addition, a minimum of one effluent air sample will be collected during the day of the SVE testing to verify destruction efficiency of the SVE system.

Task 4: Laboratory Analysis

Soil, groundwater, and air samples will be analyzed for TPHG using U.S. Environmental Protection Agency (USEPA) Method 8015B/DHS LUFT, and for BTEX, MTBE, Ethyl Tertiary Butyl Ether (ETBE), Tertiary Amyl Methyl Ether (TAME), Di-isopropyl Ether (DIPE), tertiary butyl alcohol (TBA), and 1,2-dichloroethane (1,2-DCA) using USEPA Method 8260B.

Task 5: Report Preparation

Following completion of the additional site characterization activities, a report will be submitted documenting all work activities and presenting the findings of the additional assessment. The report will be submitted within approximately 6 weeks of receiving all analytical results.

SCHEDULE

Following approval of this *Work Plan*, Stratus will secure well installation permits from SCEMD and the work will be scheduled. Approximately 3 weeks will be required for a

C-57 licensed contractor to become available. The SVE testing will be promptly scheduled following the well installation activities.

If you have any questions or comments concerning this *Work Plan*, please contact Gowri Kowtha at (530) 676-6001.

Sincerely,

STRATUS ENVIRONMENTAL, INC.

Scott Bittinger

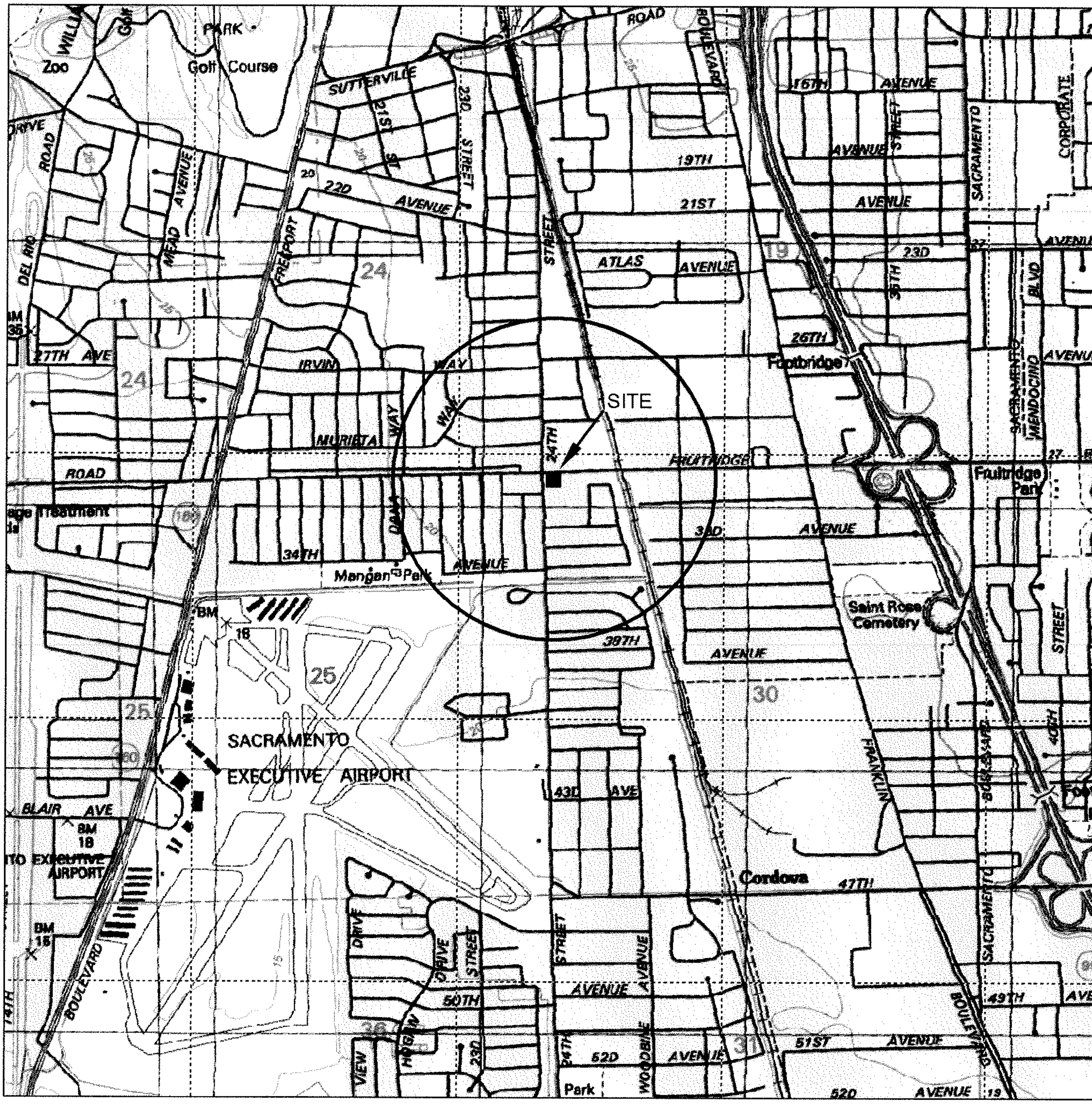
Scott G. Bittinger, P.G.
Project Geologist

Gowri S. Kowtha, P.E.
Project Manager

cc: Mr. Bal Soin, Kwik Serv Fueling Station
Ms. Christyl Escarda, Central Valley Regional Water Quality Control Board

Attachments:

Attachments:	Figure 1	Site Location Map
	Figure 2	Site Plan
	Appendix A	Field Practices and Procedures and Quality Assurance Plan



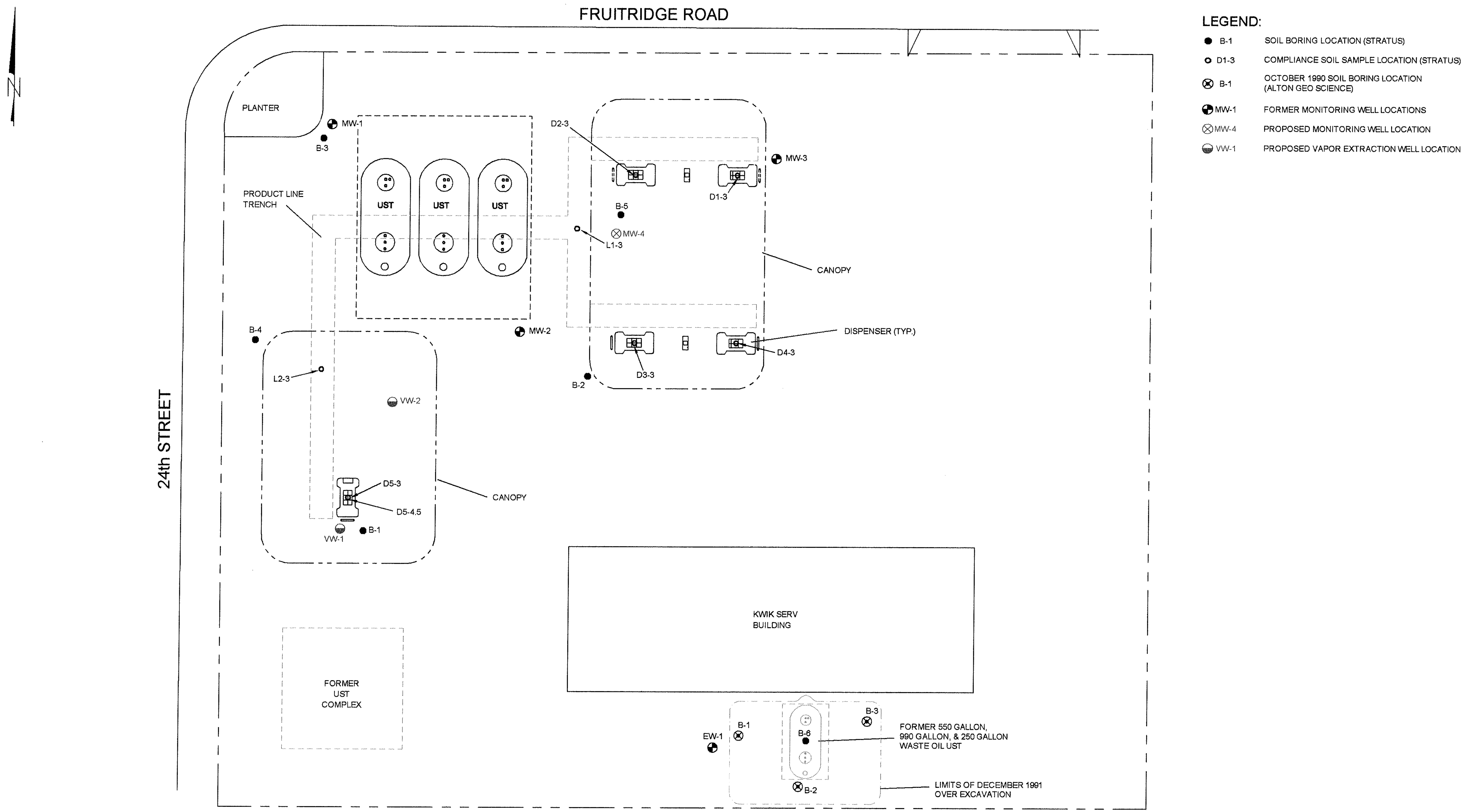
GENERAL NOTES:
BASE MAP FROM U.S.G.S.
SACRAMENTO, CA.
7.5 MINUTE TOPOGRAPHIC
PHOTOREVISED 1980

QUADRANGLE LOCATION

0 2000 FT

SCALE 1:24,000

STRATUS ENVIRONMENTAL, INC.	KWIK SERV 2400 FRUITRIDGE ROAD SACRAMENTO, CALIFORNIA **SITE LOCATION MAP**	FIGURE 1 PROJECT NO. 2029-2400-01



Kwik Serv\Workplan JMP REV May 03, 2005 Kwik Serv Siteplan.dwg

NOTE: LOCATIONS OF ALL FORMER & CURRENT SITE FEATURES ARE APPROXIMATE

STRATUS ENVIRONMENTAL, INC.

0 20 FT
HORZ. SCALE

KWIK SERV FUELING STATION
2400 FRUITRIDGE ROAD
SACRAMENTO, CALIFORNIA

SITE PLAN

FIGURE
2

PROJECT NO.
2029-2400-1

APPENDIX A

FIELD PRACTICES & PROCEDURES
AND
QUALITY ASSURANCE PLAN

FIELD PRACTICES AND PROCEDURES AND QUALITY ASSURANCE PLAN

General procedures used by Stratus in site assessments for drilling exploratory borings, collecting samples, installing monitoring wells, sampling monitoring wells, analytical procedures, and assessment of data are described herein. These general procedures are used to provide consistent and reproducible results. However some procedures may be modified based on site conditions. In addition, this appendix presents a quality assurance plan adopted in conducting the activities described here.

PRE-FIELD WORK ACTIVITIES

Health and Safety Plan

Field work performed by Stratus at the site is conducted according to guidelines established in a Site Health and Safety Plan (SHSP). The SHSP is a document which describes the hazards that may be encountered in the field and specifies protective equipment, work procedures, and emergency information. A copy of the SHSP is at the site and available for reference by appropriate parties during work at the site.

Locating Underground Utilities

Prior to commencement of any work that is to be below surface grade, the location of the excavation, boring, etc., is marked with white paint as required by law. An underground locating service such as Underground Service Alert (USA) is contacted. The locating company contacts the owners of the various utilities in the vicinity of the site to mark the locations of their underground utilities. Any invasive work is preceded by hand auguring to a minimum depth of five feet below surface grade to avoid contact with underground utilities.

FIELD METHODS AND PROCEDURES

Drilling

Soil borings will be drilled using a truck-mounted, hollow stem auger drill rig. Soil samples for logging will be obtained from auger-return materials and by advancing a modified California split-spoon sampler equipped with brass or stainless steel liners into undisturbed soil beyond the tip of the auger. Soils will be logged by a geologist according to the Unified Soil Classification System and standard geological techniques.

Soil sampling equipment will be cleaned with a detergent water solution (Liqonox or TCP), rinsed with clean water, and equipped with clean liners between sampling intervals. A consulting geologist will oversee a drilling company steam clean augers and samplers between each boring to reduce the possibility of cross contamination. Steam cleaning effluent will be contained in 55-gallon drums and temporarily stored onsite. The disposal of the effluent will be the responsibility of ARCO.

Soil Classification

Samples will be classified onsite by the field geologist in accordance with the Unified Soil Classification System. Representative portions of the samples will be retained for further examination and for verification of the field classification. Logs of the borings indicating the depth and identification of the various strata and pertinent information will be prepared. Exploratory boring logs and well construction details will be prepared for the final written report.

Soil Sample Screening

Soil samples selected for chemical analysis will be determined from a head-space analysis using a PID or an FID. The soil will be placed in a Ziploc®-type resealable plastic bag and allowed to reach ambient temperature, at which time the PID probe will be inserted into the bag. The total volatile hydrocarbons present are detected by the PID and reported in parts per million by volume (ppmv).

A PID is calibrated by entering the known concentration (in ppmv) of a containerized gas (typically isobutylene) into the display function of the PID machine. The containerized gas is released through an inert (plastic) tube into the sensory receiver of the PID. The PID normalizes its volatile organic compounds (VOC) detection sensors to match the known concentration of the gas being input into the PID machine.

Soil Sample Collection

During drilling, soil samples will be collected in clean brass, two by six inch tubes. The tubes will be set in an 18-inch-long split-barrel sampler. The sampler will be conveyed to the bottom of the borehole attached to a wire-line hammer device on the drill rig. When possible, the split-barrel sampler will be driven its entire length, either hydraulically or by repeatedly pounding a 140-pound hammer using a 30-inch drop. The number of drops (blows) used to drive the sampler will be recorded on the boring log. The sampler will be extracted from the borehole, and the tubes containing the soil samples will be removed. Upon removal, the ends of the lowermost tube will be sealed with Teflon™ sheets and plastic caps. Soil samples for chemical analysis will be labeled, placed on ice, and delivered to a state-certified analytical laboratory, along with the appropriate chain-of-custody documentation.

Label information includes a unique sample identification number, job identification number, date, and time. After labeling, all soil and water samples are placed in a Ziploc® type bag and placed in an ice chest cooled to approximately 4° C. Upon arriving at Stratus' office, the samples are transferred to a locked refrigerator cooled to approximately 4° Celsius. Chemical preservation is controlled by the required analysis and is noted on the chain-of-custody form.

The number of samples collected to evaluate impact to soil is determined by the overseeing registered geologist. This information and rationale is typically presented in the work plan.

Stockpiled Drill Cuttings and Soil Sampling

Soil generated during drilling operations will be stockpiled onsite. The stockpile will be set on and covered by plastic sheeting in a manner to prevent rain water from coming in contact with the soil. Prior to collecting soil samples, Stratus personnel will calculate the approximate volume of soil in the stockpile. The stockpile will then be divided into 50 cubic yard (volume) sections, if warranted, for sampling. Soil samples will be collected at 0.5 to 2 feet below the surface of the stockpile. Four soil samples will be collected from the stockpile and composited into one sample by the laboratory prior to analysis. The soil samples will be collected in clean brass, two by six inch tubes using a hand driven sampling device. To reduce the potential for cross-contamination between samples, the sampler will be cleaned between each sampling event. Upon recovery, the sample container will be sealed at each end with Teflon™ sheeting and plastic caps to minimize the potential of volatilization and cross-contamination prior to chemical analysis. The soil sample will be labeled, placed in an ice chest cooled to 4° C, and delivered to a state-certified analytical laboratory, along with the appropriate chain-of-custody documentation.

Sample Identification and Chain-of-Custody

Sample identification and chain-of-custody procedures document sample possession from the time of collection to ultimate disposal. Each sample container submitted for analysis has a label affixed to it to identify the job number, sampler, date and time of sample collection, and a sample number unique to that sample. This information, in addition to a description of the sample, field measurements made, sampling methodology, names of onsite personnel, and any other pertinent field observations, are recorded on the borehole log or in the field records. A chain-of-custody form is used to record possession of the sample from time of collection to its arrival at the laboratory. When the samples are shipped, the person in custody of them relinquishes the samples by signing the chain-of-custody form and noting the time.

Monitoring Well Installation

Monitoring wells will be completed by installing two or four-inch-diameter Schedule 40 polyvinyl chloride (PVC) casing. The two-inch diameter monitoring wells will be installed using 8-inch diameter hollow stem augers, and the four-inch diameter monitoring wells will be installed using 10-inch diameter hollow stem augers.

Monitoring wells will be constructed using threaded, factory-perforated and blank Schedule 40 PVC. The perforated interval consists of slotted casing, 0.01 or 0.02 inches wide by 1.5 inch long slots, with 42 slots per foot. The screened interval will allow for seasonal fluctuation in water level and for monitoring floating product. A threaded PVC cap is secured to the bottom of the casing. The well casing is thoroughly washed and/or steam cleaned, or may be purchased as pre-cleaned, prior to completion.

A filter pack of graded sand will be placed in the annular space between the PVC casing and the borehole wall. Sand will be added to the borehole through the hollow stem of the augers to provide a uniform filter pack around the casing and to stabilize the borehole. The sand pack will be placed to a maximum of 2 feet above the screens, followed by a minimum 1-foot seal consisting of bentonite pellets.

Cement grout containing 5 percent bentonite will be placed above the bentonite seal to the ground surface. A concrete traffic-rated vault box will be installed over the monitoring wells. A watertight locking cap will be installed over the top of the well casing. Monitoring well elevations will be surveyed by a state-certified land surveyor to the nearest 0.01 vertical feet relative to mean sea level (MSL). Horizontal coordinates of the wells will also be obtained at the same time.

Vapor Extraction Well Completion

The borehole diameter for a vapor extraction well is typically a minimum of four inches larger than the outside diameter of the casing.

A vapor extraction well is typically cased with threaded, factory-perforated and blank Schedule 40 PVC. The perforated interval consists of slotted casing, generally with 0.01 or 0.02 inch-wide by 1.5-inch-long slots, with 42 slots per foot. A threaded or slip PVC cap is secured to the bottom of the casing. The slip cap can be secured with stainless steel screws, friction or PVC cement if the well is not completed into ground water. Centering devices may be fastened to the casing to ensure even distribution of filter material and grout within the borehole annulus. The well casing is thoroughly washed and/or steam cleaned, or may be purchased as pre-cleaned, prior to completion.

Setting the casing inside the hollow-stem auger, sand or gravel filter pack material is poured into the annular space to fill from boring bottom to generally one foot above the perforated interval. After setting the filter pack a one to two foot thick bentonite plug is set above the filter pack to prevent grout from infiltrating into the filter pack. A regulatory approved annular filling material is used to fill the annulus from the bentonite plug to within 10 feet the surface (if the well depth and screen interval allow). The remaining nine feet of annulus is filled with either neat cement, cement with five percent (by volume) bentonite or sand-cement grout. The annular filling material is placed by a method approved by the regulatory agency overseeing the site. The remaining foot of the well is completed using a traffic-rated vault is installed around each wellhead. A traffic-rated vault it is typically set 1/2-inch above grade to minimize surface water from entering the vault. In areas that may be plowed for snow removal the vault is set flush with the surface to prevent damage to the vault by a snow plow.

In some cases multiple strings of casing will be run in the boring. This is known as a nested, dual, or multiple completion. These types of completions are performed similar to the single completions with the exception that bentonite is placed between the screened intervals which isolates the intervals.

Equipment Cleaning

Sample bottles, caps, and septa used in sampling for volatile and semivolatile organics will be triple rinsed with high-purity deionized water. After being rinsed, sample bottles will be dried overnight at a temperature of 200°C. Sample caps and septa will be dried overnight at a temperature of 60°C. Sample bottles, caps, and septa will be protected from solvent contact between drying and actual use at the sampling site. Sampling containers will be used only once and discarded after analysis is complete.

Plastic bottles and caps used in sampling for metals will be soaked overnight in a 1 percent nitric acid solution. Next, the bottles and caps will be triple rinsed with deionized water. Finally, the bottles and caps will be air dried before being used at the site. Plastic bottles and caps will be constructed of linear polyethylene or polypropylene. Sampling containers will be used only once and discarded after analysis is complete. Glass and plastic bottles used by Stratus to collect groundwater samples are supplied by the laboratory.

Before the sampling event is started, equipment that will be placed in the well, or will come in contact with groundwater, will be disassembled and cleaned thoroughly with detergent water, and then steam cleaned with deionized water. Any parts that may absorb contaminants, such as plastic pump valves, etc., will be cleaned as described above or replaced. During field sampling, equipment surfaces that are placed in the well or contact groundwater will be steam cleaned with deionized water before the next well is purged or sampled.

Soil samples are collected in new, pre-cleaned brass liners. These sample liners are either used by themselves, or are inserted in the sampling equipment. Soil samples are not collected with or in reusable equipment.

Cone Penetrometer Tool (CPT) Testing

The CPT method consists of advancing a cone-tipped cylindrical probe (1.7 inches in diameter) into the ground while simultaneously measuring the resistance to penetration. The CPT method determines soil lithology by comparing the force (cone bearing pressure) required to advance the probe (Q_t) to the friction ratio (R_f) (R_f equals sleeve friction [F_s] divided by the probe tip load, times the penetration pore pressure [U_d]). Computer generated CPT logs will be plotted in the field, providing the field representative a graphical log of subsurface soil lithology. A CPT test data report, which will include logs of all CPT data, graphical geologic logs, and additional information on the CPT technique, will be submitted with the final report. CPT testing will be performed in accordance with American Society of Testing and Materials (ASTM) Method D3441.

The cone testing will be performed inside of a grout collar installed at the ground surface. The grout collar will allow the CPT contractor to backfill the boring as the steel rods are retracted from the hole. Continuous grouting will prevent cross contamination of water bearing zones that can occur through an open borehole. The boring will be backfilled to surface grade. An asphalt patch will be placed over the borehole.

Direct Push Technology, Water Sampling

A well known example of direct push technology for water sampling is the Hydropunch®. For the purpose of this field method, the term hydropunch will be used instead of direct push technology for water sampling. Hydropunch samples will be collected by placing a disposable steel tip on the end of a two-inch diameter rod containing five feet of disposable 1-inch diameter slotted PVC casing. The sampling rods are pushed to the desired depth using the CPT truck. Depth discreet samples are obtained by retracting the rods approximately four feet, exposing the screen at the desired sampling interval. Samples are collected by lowering a bailer inside the steel rods and recovering groundwater. Groundwater is poured from the bailer into laboratory supplied glass vials. The water samples will be labeled, placed on ice, and delivered to a state-certified analytical laboratory along with the appropriate chain-of-custody documentation. The inside and outside of the two-inch diameter steel rods are steam cleaned between sampling events to prevent cross contaminating groundwater samples.

Soil Sampling

Soil samples will be collected at the CPT locations using a retractable sampler equipped with two 1.25-inch by 6-inch brass sleeves. Soil sampling is conducted by advancing the sampler to the top of the desired sampling depth. The CPT operator subsequently retracts the rods approximately 12 inches, exposing the brass sleeves in the borehole. The sampler is then driven into native soil.

Groundwater and Liquid-Phase Petroleum Hydrocarbon Depth Assessment

A water/hydrocarbon interface probe is used to assess the liquid-phase petroleum hydrocarbon (LPH) thickness, if present, and a water level indicator is used to measure the groundwater depth in monitoring wells that do not contain LPH. Depth to ground water or LPH is measured from a datum point at the top of each monitoring well casing. The datum point is typically a notch cut in the north side of the casing edge. If a water level indicator is used, the tip is subjectively analyzed for hydrocarbon sheen.

Subjective Analysis of Groundwater

Prior to purging, a water sample is collected from the monitoring well for subjective assessment. The sample is retrieved by gently lowering a clean, disposable bailer to approximately one-half the bailer length past the air/liquid interface. The bailer is then retrieved, and the sample contained within the bailer is examined for floating LPH and the appearance of a LPH sheen.

Monitoring Well Purging and Sampling

If the depth to groundwater is above the top of the screens of the monitoring well, then the wells are purged. Monitoring wells are purged using a electrical submersible pump or bailer until pH, temperature, and conductivity of the purge water has stabilized and a minimum of three well volumes of water have been removed. Wells are typically purged at the rate of 1 gallon per minute (gpm), though will not exceed 2 gpm. If three well volumes can not be removed in one half hour's time the well is allowed to recharge to 80% of the original level. After recharging, a ground water sample is then removed from each of the wells using a disposable bailer. Groundwater purged from the monitoring wells is typically transported to a holding facility in West Sacramento.

A Teflon bailer will be the only equipment used for well sampling. When samples for volatile organic analysis are being collected, the flow of groundwater from the bailer will be regulated to minimize turbulence and aeration. Glass bottles of at least 40-milliliters volume and fitted with Teflon™-lined septa will be used in sampling for volatile organics. These bottles will be filled completely to prevent air from remaining in the bottle. A positive meniscus forms when the bottle is completely full. A convex Teflon™ septum will be placed over the positive meniscus to eliminate air. After the bottle is capped, it is inverted and tapped to verify that it contains no air bubbles. The sample containers for other parameters will be filled, filtered as required, and capped.

The water sample is collected, labeled, and handled according to the Quality Assurance Plan. Water generated during the monitoring events is disposed of at approved water recycling facilities.

Quality Assurance Plan

Procedures to provide data quality have been established and documented so that conditions adverse to quality, such as deficiencies, deviations, nonconforments, defective material, services, and/or equipment, can be promptly identified and corrected.

Internal Quality Assurance Checks

Internal quality assurance procedures will be used to provide reliability of monitoring and measurement of data. Both field and laboratory quality assurance checks as listed below will be used to evaluate the reliability of sampling and analysis results. Tables 1 through 5 present data quality indicators (DQI) used by the laboratory to meet internal quality assurance procedures. Internal quality assurance procedures generally include:

Laboratory Quality Assurance

- Documentation of instrument performance checks,
- Documentation of instrument calibration,
- Documentation of the traceability of instrument standards, samples, and data, and
- Documentation of analytical and QC methodology (QC methodology includes use of spiked samples, duplicate samples, split samples, use of reference blanks, and check standards to check method accuracy and precision).

Field Quality Assurance

Stratus has developed field DQIs which are presented in Table 6. In addition the to the DQIs the following internal checks will also be conducted.

- Documentation of sample preservation and transportation, and
- Documentation of field instrument calibration and irregularities in performance.

General Sample Collection and Handling Procedures

Proper collection and handling are essential to ensure the quality of a sample. Each sample is collected in a suitable container, preserved correctly for the intended analysis, and stored prior to analysis for no longer than the maximum allowable holding time. Details on the procedures for collection and handling of samples used on this project can be found in this section and in the attached DQI tables.

Soil and Water Sample Labeling and Preservation

Label information includes a unique sample identification number, job identification number, date, and time. After labeling, all soil and water samples are placed in a Ziploc® type bag and placed in an ice chest cooled to approximately 4° C. Upon arriving at Stratus' office, the samples are transferred to a locked refrigerator cooled to approximately 4° C. Chemical preservation is controlled by the required analysis and is noted on the chain-of-custody form. Trip blanks supplied by the laboratory accompany the groundwater sample containers and groundwater samples.

Upon recovery, the sample container is sealed to minimize the potential of volatilization and cross-contamination prior to chemical analysis. Soil sampling tubes are typically closed at each end with Teflon™ sheeting and plastic caps. The sample is then placed in a Ziploc® type bag and sealed. The sample is labeled and refrigerated at approximately 4° Celsius for delivery, under strict chain-of-custody, to the analytical laboratory.

Chain of Custody

The chain-of-custody form is used to record possession of the sample from time of collection to its arrival at the laboratory. When the samples are shipped, the person in custody of them relinquishes the samples by signing the chain-of-custody form and noting the time. The sample-control officer at the laboratory verifies sample integrity and confirms that the samples are collected in the proper containers, preserved correctly, and contain adequate volumes for analysis. These conditions are noted on a Laboratory Sample Receipt Checklist (see attached) which will be included in the laboratory report.

If these conditions are met, each sample is assigned a unique log number for identification throughout analysis and reporting. The log number is recorded on the chain-of-custody form and in the legally-required log book maintained by the laboratory. The sample description, date received, client's name, and other relevant information is also recorded.

Analytical Methods

Soil and groundwater samples collected during exploratory site investigation activities and development and sampling of monitoring wells, will be analyzed under a standard 10-day turnaround time. Samples are analyzed using analytical methods outlined in EPA Manual SW 846 and approved by the California Regional Water Quality Control Board-Central Valley Region in the Leaking Underground Fuel Tanks (LUFT) manual and appendices.

Samples collected during the investigation of petroleum hydrocarbon impacted sites are typically analyzed for total petroleum hydrocarbons as gasoline ([C_2-C_{12} range] TPHG) by U.S. EPA Method 8015. Benzene, Toluene, ethylbenzne, and total xylenes (BTEX) are analyzed using U.S. EPA Method 8020/8021.

The attached tables 1 through 5 present the state-certified laboratory's calibration and quality assurance procedures for the above mentioned analytical methods. Internal laboratory quality assurance checks will be the responsibility of the contract laboratories. Data and reports submitted by field personnel and the contract laboratory will be reviewed and maintained in the project files.

Data Review and Verification

Data quality indicator parameters will be evaluated by the contract state-certified laboratory against the frequency and acceptance criteria described in the Lab DQI Tables. Data that are out of compliance with the laboratory criteria will be flagged in the laboratory analytical report and will be identified in the report summary table. Stratus will evaluate the field procedures against the frequency and acceptance criteria identified in the field DQI Table. The overseeing registered professional will review field documentation (boring logs, sampling sheets, Chain-of-Custody documents, lab sample receipt forms, etc.,) and identify relevant issues/problems that affect data and overall applicability.

DATA QUALITY INDICATORS FOR
TOTAL PETROLEUM HYDROCARBONS (TPH) and VOLATILE ORGANIC COMPOUNDS

Method 8015B, Method 8021A, Method 8260

Table 1. Summary of Required Quantitation Limits, Holding Times, and Preservation for Total Petroleum Hydrocarbons (TPH) as Gasoline and Diesel, and Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry

Analytical Parameter	**Technical Holding Times**	**Preservation**
Total Petroleum Hydrocarbons (TPH) as Gasoline in Water Samples	14 days from collection	HCl or H_2SO_4 to pH<2; Cool to 4°C ±2°C
TPH as Gasoline in Soil Samples	14 days from collection	Cool to 4°C ±2°C; sealed zero headspace containers
TPH as Diesel in Water Samples	Extraction: 14 days from collection; Analysis: 40 days from extraction	HCl or H_2SO_4 to pH<2; Cool to 4°C ±2°C
TPH as Diesel in Soil Samples	Extraction: 14 days from collection; Analysis: 40 days from extraction	Cool to 4°C ±2°C
Volatile Organic Compounds (VOCs) in Water	14 days from collection	HCl to pH <2; Cool to 4°C ±2°C
VOCs in Soil	14 days from collection	Cool to 4°C ±2°C; sealed zero headspace containers

Sample Containers:

Water: 3 x 40mL VOA vials with Teflon-lined septum caps
Soil: 1 x Brass Sleeve

Data Calculations and Reporting Units:

Report water sample results in concentration units of micrograms per liter (µg/L). Report soil sample results in micrograms per kilogram (µg/kg).

For rounding results, adhere to the following rules:

a) If the number following those to be retained is less than 5, round down;
b) If the number following those to be retained is greater than 5, round up; or
c) If the number following the last digit to be retained is equal to 5, round down if the digit is even, or round up if the digit is odd.

Table 2. Target Compound List and Required Quantitation Limits (RQL) for Method 8015B

COMPOUND	RQL Water µg/L	RQL Soil µg/kg
Gasoline	50	1000
Diesel	50	1000

Table 3. Summary of Calibration Internal Quality Control Procedures for SW-846 Method 8015B

QC Element	Frequency	Acceptance Criteria	Corrective Action
Method Blank (MB)	Gasoline: One per batch (1 per 20 samples minimum) Diesel: One per batch (1 per 20 samples minimum)	< RQL for each compound	Gasoline: Perform maintenance as needed, reanalyze blank. If after re-analysis, blank > RQL, STOP. Determine source and correct. Or if blank exceeds the RQL but (1) the blank value is 10x less than sample value or (2) samples are ND, data is reported. Diesel: Perform maintenance as needed, reanalyze blank. If blank exceeds the RQL but (1) the blank value is 10x less than sample value or (2) samples are ND, data is reported If blank exceeds the RL and samples have hits, which are not >10x blank value, re-extract and reanalyze.
Matrix Spike and Matrix Spike Duplicate (MS/MSD)	One MS/MSD set per batch (1 MS/MSD set per 20 samples minimum)	TPHg: 60-140% of expected value TPHd: 50-150% of expected value	If LCS is within acceptance limits, report with qualifier
Surrogate Spike	Every sample and MB at midpoint of calibration range	TPHg: 60-140% of expected value TPHd: 50-150% of expected value	Re-extract and /or re-analyze. If still out, report with qualifier.
Laboratory Control Sample (LCS)	Gasoline: One each 12-hour period; Diesel: One per batch	TPHg: 70-130% of expected value TPHd: 60-140% of expected value	Re-analyze once. Re-extract and/or re-analyze all associated samples

Table 4. Target Compound List and Required Quantitation Limits (RQL) for Method 8260B

Analyte	**RQL µg/L**	**RQL µg/Kg**
Benzene	0.5	5.0
Toluene	0.5	5.0
Ethylbenzene	0.5	5.0
Total Xylenes	0.5	5.0
Fuel Oxygenates:		
Methyl tertiary butyl ether	0.5	5.0
Ethyl tertiary butyl ether	1.0	5.0
Di-isopropyl ether	1.0	5.0
Tertiary amyl methyl ether	1.0	5.0
1,2 dichloroethane	0.5	5.0
tert-butyl alcohol	5.0	25.0

Table 5. Summary of Internal Quality Control Procedures for Method 8260

QC Element	Frequency	Acceptance Criteria	Corrective Action
Method Blank (MB)	One per batch (1 per 20 samples minimum)	< RQL for each compound	Perform maintenance as needed, reanalyze blank. If after re-analysis, blank > RQL, STOP. Determine source and correct. Or if blank exceeds the RQL but (1) the blank value is 10x less than sample value or (2) samples are ND, data is reported.
Matrix Spike and Matrix Spike Duplicate (MS/MSD)	One MS/MSD set per batch (1 MS/MSD set per 20 samples minimum)	Water Sample: 60-140% of expected value Soil Sample: 60-140% of expected value ≤25% RPD between MS and MSD	If LCS is within the acceptance limits, report data with a qualifier.
Surrogate Spikes	Every sample, standard and method blank	Water Sample: 70-130% of expected value Soil Sample: 60-140% of expected value	Re-prep and /or re-analyze samples once. If still out, report results with a qualifier
Laboratory Control Sample (LCS)	One per batch	Water Sample: 70-130% of expected value Soil Sample: 70-130% of expected value	Re-analyze once. If still out, perform maintenance if required and re-calibrate. Re-prep and re-analyze all associated samples.

Alpha Analytical, Inc.

Phone : (775) 355-1044 FAX : (775) 355-0406

Sample Receipt Checklist

Date Report is due to Client : 2/5/02 Date of Notice : 2/7/02 2:43:18

Please take note of any Non-Compliant check marks. If we receive no response concerning these items within 24 hours of the date of this notice, all of the samples will be analyzed as requested.

Client Name: Client Project ID : Sample Reports

Project Manager : John Smith Client's Phone : (123) 456-7890 Client's FAX : (098) 765-4321

Work Order Number : TST99999999 Date Received : 2/7/02 2:42:03 Received by:

Chain of Custody (COC) Information

Carrier name: Client

Chain of custody present ?	Yes	No	
Custody seals intact on shippping container/cooler ?	Yes	No	Not Present
Custody seals intact on sample bottles ?	Yes	No	Not Present
Chain of custody signed when relinquished and received ?	Yes	No	
Chain of custody agrees with sample labels ?	Yes	Non-Compliant	
Internal Chain of Custody (COC) requested ?	Yes	No	
Sub Contract Lab Used :	None	SEM	Other (see comments)

Sample Receipt Information

Shipping container/cooler in good condition?	Yes	No	Not Present
Samples in proper container/bottle?	Yes	Non-Compliant	
Sample containers intact?	Yes	No	
Sufficient sample volume for indicated test?	Yes	No	

Sample Preservation and Hold Time (HT) Information

All samples received within holding time?	Yes	Non-Compliant		Cooler Temperature
Container/Temp Blank temperature in compliance (0-6°C)?	Yes	Non-Compliant		4 °C
Water - VOA vials have zero headspace?	Yes	Non-Compliant	No VOA vials submitted	
TOC Water - pH acceptable upon receipt ?	Yes	No	N/A	

TOC Samples should have a pH<2 (H2SO4)

Analytical Requirement Information

Are non-Standard or Modified methods requested ?	Yes	No	
Are there client specific Project requirements ?	Yes	No	If YES : see the Chain of Custody (COC)

Comments :

DATA QUALITY INDICATORS
FIELD PROCEDURES AND CONDITIONS

Table 6 *Summary of Field Data Quality Indicators*

QC Element	Frequency	Acceptance Criteria	Corrective Action
Field Duplicate	One per 20 or more aqueous samples; minimum of 1 sample per soil sampling event.	Water Sample: ≤30% RPD [a] Soil Sample: ≤50% RPD	Water Samples: Case narrative of variability. Collect additional samples during next sampling event. Soil Samples: Provide a case narrative for variability.
Field Blank (FB)	One per 20 or more aqueous samples.	Water: < RL for each compound Soil: Not applicable	Investigate the source of contamination and document. Correct sampling/handling protocols. Collect a trip blank for analysis during next groundwater sampling event.
Trip Blank (TB)	To be determined as necessary based in analytical results of field blanks	Water: < RL for each compound Soil: Not applicable	Investigate the source of contamination and document. Correct sampling/handling protocols. Collect bottle blank during next sampling event.
Bottle Blank (BB)	One per lot of sample bottles. Analyze if contamination is detected in TB.	Water: < RL for each compound Soil: Not applicable	Investigate the source of contamination and document. Correct sampling/handling protocols. Resample if associated data verification action is not acceptable for affected samples.
Review of field notes/boring logs, chain of custody documentation, and laboratory sample receipt documentation	NA	Water: Professional Judgment Soil: Professional Judgment	Investigate, document, and correct sampling/handling protocols, as appropriate. Resample if associated data verification action is not acceptable for affected samples.

[a] $RPD = 100 \times \frac{x_1 - x_2}{(x_1 + x_2)/2}$